

WHAT IS CLAIMED IS:

1 1. A method for increasing throughput over network connections experiencing
2 data loss due to non-congestion-based packet loss, comprising:
3 identifying, at a network node, non-congestion-based packet loss over a
4 network connection between a sending module and the network node;
5 sending a loss notification signal from the network node to the sending
6 module in response to identification of the non-congestion-based packet loss;
7 verifying the non-congestion-based packet loss at the sending module; and
8 performing a first loss recovery procedure, different from a second loss
9 recovery procedure associated with congestion-based packet loss, if the non-congestion-
10 based packet loss is verified at the sending module.

1 2. The method of Claim 1, wherein the non-congestion-related packet loss
2 comprises packet loss due to bit errors (PLB).

1 3. The method of Claim 1, wherein sending a loss notification from the
2 network node comprises embedding data associated with the packet experiencing packet
3 loss into a signaling protocol packet, and sending the signaling protocol packet as the loss
4 notification to the sending module.

1 4. The method of Claim 3, wherein sending the signaling protocol packet to
2 the sending module further comprises embedding the signaling protocol packet into the
3 payload of a network layer packet, and sending the signaling protocol packet to the sending
4 module via the network layer packet.

1 5. The method of Claim 4, wherein verifying the non-congestion-based packet
2 loss comprises:
3 forwarding the signaling protocol packet from a network layer of the
4 sending module to a signaling protocol layer of the sending module;
5 identifying a transport layer protocol in a next header field within the data
6 embedded in the signaling protocol packet;

7 informing the identified transport layer protocol of the non-congestion-
8 based packet loss; and
9 verifying the non-congestion-based packet loss via the identified transport
10 layer protocol.

1 6. The method of Claim 5, wherein verifying the non-congestion-based packet
2 loss via the identified transport layer protocol comprises:
3 marking the packet experiencing non-congestion-based packet loss to
4 indicate that the loss notification signal was received from the network node for the packet;
5 and
6 enabling the performance of the first loss recovery procedure in response to
7 receipt of a predetermined number of duplicate acknowledge packets from the network
8 node for the marked packet.

1 7. The method of Claim 5, further comprising dropping the signaling protocol
2 packet if the transport layer protocol in the next header field is not among a predetermined
3 group of transport layer protocols.

1 8. The method of Claim 5, wherein the transport layer protocol comprises any
2 one of TCP, UDP, and TFRC.

1 9. The method of Claim 4, wherein the network layer packet comprises an
2 Internet Protocol (IP) packet.

1 10. The method of Claim 4, wherein the network layer packet comprises a
2 protocol field identifying a protocol of the signaling protocol packet.

1 11. The method of Claim 3, wherein embedding data associated with the packet
2 experiencing non-congestion-based packet loss comprises copying as many bytes from the
3 packet experiencing non-congestion-based packet loss as can fit into the signaling protocol
4 packet within the network layer packet.

1 12. The method of Claim 3, wherein the signaling protocol packet comprises a
2 next header field identifying a transport layer protocol of the sending module.

1 13. The method of Claim 1, wherein verifying the non-congestion-based packet
2 loss at the sending module comprises:

3 marking the packet experiencing non-congestion-based packet loss
4 to indicate that the loss notification signal was received from the network node for the
5 packet; and

6 enabling the performance of the first loss recovery procedure in response to
7 receipt of a predetermined number of duplicate acknowledge packets from the network
8 node for the marked packet.

1 14. The method of Claim 13, further comprising continuing normal
2 communication at the sending module during a time required to receive the predetermined
3 number of duplicate acknowledge packets.

1 15. The method of Claim 1, wherein performing the first loss recovery
2 procedure comprises:

3 sending the packet experiencing packet loss;
4 setting a slow start threshold equal to a number of packets in flight;
5 until the packet experiencing packet loss is acknowledged, incrementing a
6 congestion window for each duplicate acknowledge received; and

7 setting the congestion window equal to the slow start threshold when the
8 packet experiencing packet loss is acknowledged.

1 16. The method of Claim 1, wherein the second loss recovery procedure
2 comprises a standard congestion response procedure.

1 17. The method of Claim 1, wherein identifying non-congestion-related packet
2 loss comprises distinguishing between congestion-related packet loss and non-congestion-
3 related packet loss over the network connection.

1 18. The method of Claim 1, wherein identifying non-congestion-related packet
2 loss comprises identifying bit errors associated with a packet transmitted to the network
3 node using checksum information provided to the network node via the packet.

1 19. The method of Claim 1, wherein the network connection comprises at least
2 one of a wireless link and a wired link.

1 20. A communication device for communicating information over a network,
2 comprising:

3 a receiver for receiving indications of packet loss due to bit errors (PLB)
4 pertaining to one or more packets previously transmitted via the communication device;

5 a packet marking module coupled to receive the PLB indications and to
6 mark the respective previously-transmitted packets as potentially subject to PLB;

7 a verification module coupled to receive a packet loss indication and
8 coupled to the packet marking module to determine whether the packet loss indication
9 corresponds to any of the previously-transmitted packets that have been marked; and

10 a non-congestion-based loss recovery module coupled to the verification
11 module to perform packet loss recovery without requiring reduction of a congestion
12 window for the previously-transmitted packets that are both associated with the packet loss
13 indication and have been marked.

1 21. The communication device as in Claim 20, further comprising a congestion-
2 based loss recovery module coupled to the verification module to perform a second packet
3 loss recovery that includes a reduction of the congestion window for the previously-
4 transmitted packets that are associated with the packet loss indication and that have not
5 been marked.

1 22. The communication device as in Claim 20, wherein the packet loss
2 indication comprises at least one duplicate acknowledge (DUPACK) received from the
3 network for a particular previously-transmitted packet.

1 23. The communication device as in Claim 20, wherein the packet loss
2 indication comprises a predetermined number of duplicate acknowledges (DUPACKs)
3 received from the network for a particular previously-transmitted packet.

1 24. The communication device as in Claim 23, further comprising a counter
2 module coupled to the receiver to count the DUPACKs received from the network for the
3 particular previously-transmitted packet.

1 25. The communication device as in Claim 20, wherein the packet loss
2 indication comprises a packet acknowledge timeout notification.

1 26. The communication device as in Claim 20, further comprising a signaling
2 protocol module coupled to receive the PLB indication, extract embedded information
3 from the PLB indications, and to identify a next header indication in embedded
4 information to notify a transport layer identified by the next header indication of the
5 potential PLB.

1 27. The communication device as in Claim 26, wherein the signaling protocol
2 module is coupled to the packet marking module at the transport layer via an application
3 programming interface (API).

1 28. The communication device as in Claim 20, wherein the communication
2 device comprises a mobile device capable of wireless communication via a wireless
3 network.

1 29. The communication device as in Claim 20, wherein the communication
2 device comprises a device coupled to communicate via a landline network.

1 30. A system for increasing throughput over network connections experiencing
2 data loss due to non-congestion-based packet loss, comprising:

- 3 (a) a network element coupled to a network comprising:
4 (i) a receiver to receive packets transmitted via the network; and

5 (ii) a transmitter to transmit a loss notification signal to sources of the
6 packets experiencing the non-congestion-based packet loss; and
7 (b) a communication device coupled to the network element via the network,
8 the communication device comprising:
9 (i) a receiver to receive the loss notification signal from the network
10 element where the communication device is at least one of the sources of the packet
11 experiencing the non-congestion-based packet loss;
12 (ii) a packet marking module coupled to receive at least a portion of the
13 loss notification signal and to mark the packet as potentially subject to non-
14 congestion-based packet loss;
15 (iii) a verification module coupled to receive a packet loss indication and
16 coupled to the packet marking module to determine whether the packet loss
17 indication corresponds to any packet that have been marked; and
18 (iv) a non-congestion-based loss recovery module coupled to the
19 verification module to perform packet loss recovery without requiring reduction of
20 a congestion window for the packets that are both associated with the packet loss
21 indication and have been marked.

1 31. The system as in Claim 30, wherein the network element further comprises
2 an embedding module to embed packet header data into the loss notification signal from
3 packets experiencing non-congestion-based packet loss.

1 32. The system as in Claim 31, wherein the communication device comprises
2 an extraction module to extract a next header from the embedded packet header data to
3 identify a protocol layer to be notified of the non-congestion-based packet loss.

1 33. The system as in Claim 30, wherein the communication device further
2 comprises a congestion-based loss recovery module coupled to the verification module to
3 perform a second packet loss recovery that includes a reduction of the congestion window
4 for the packets that are associated with the packet loss indication and that have not been
5 marked.